

# Applications of Satellite Remote Sensing for Response to and Recovery from Meteorological Disasters

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18<sup>th</sup> Conference on IOAS-AOLS / Satellite Data and Technology for Forecasting and Responding to Natural Disasters  
2014 AMS Annual Meeting in Atlanta, GA, February 2-6



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# Background

- Natural hazards become disasters when they affect life or property.
- Many natural disasters are meteorological in nature, or influenced by ongoing weather:
  - Tornadoes, hurricanes, typhoons, wildfires (lightning-initiated), drought, floods, blizzards, extreme temperature, and impacts on other human-caused disasters.
- Near real-time remote sensing offers several capabilities to support disaster assessment and response.
  - In addition, the broader availability of near real time Earth remote sensing provides continuity of weather observations to support response activities.



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# The SPoRT Disasters Team

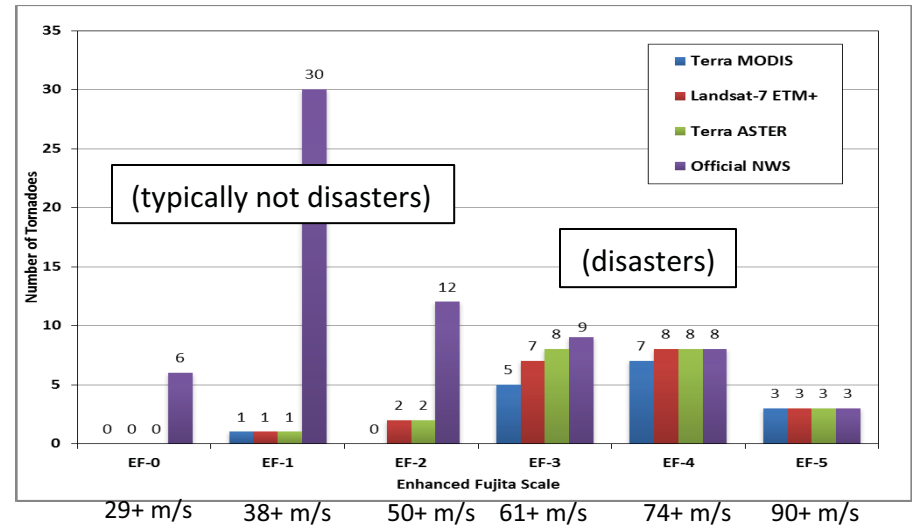
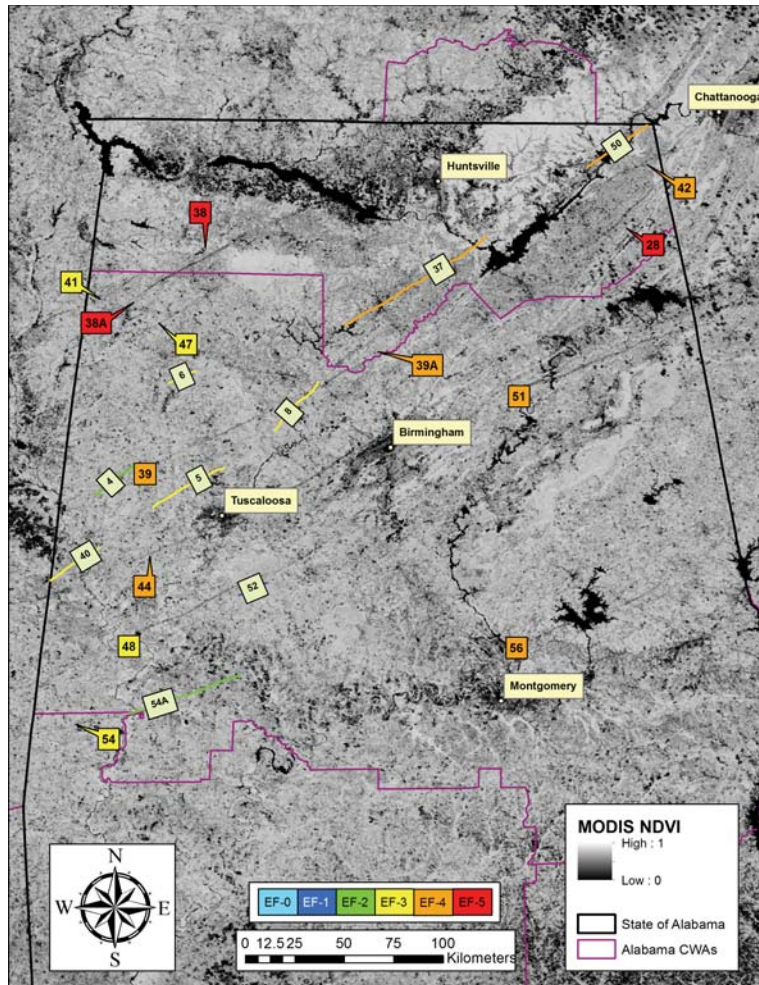
- SPoRT has a 10+ year relationship supporting NOAA's National Weather Service, providing new satellite products, analysis techniques, appropriate training, and collaborative partnerships.
- SPoRT provided imagery to NWS offices following the April 27, 2011 "Super Outbreak" of tornadoes across the southeastern U.S.
  - ROSES 2011: Applied Sciences: Disasters "feasibility study" award
- Primary goals of the feasibility study:
  - Include near real-time Earth remote sensing within the NWS "Damage Assessment Toolkit", the smartphone app used in the tornado damage survey process.
  - Demonstrate that satellite data adds value to the survey process.
  - Explore additional techniques for supporting disaster response and assessment via use of near real-time NASA, NOAA, and other data.
- SPoRT has provided imagery in support of Superstorm Sandy assessments, Super Typhoon Haiyan, and other events.



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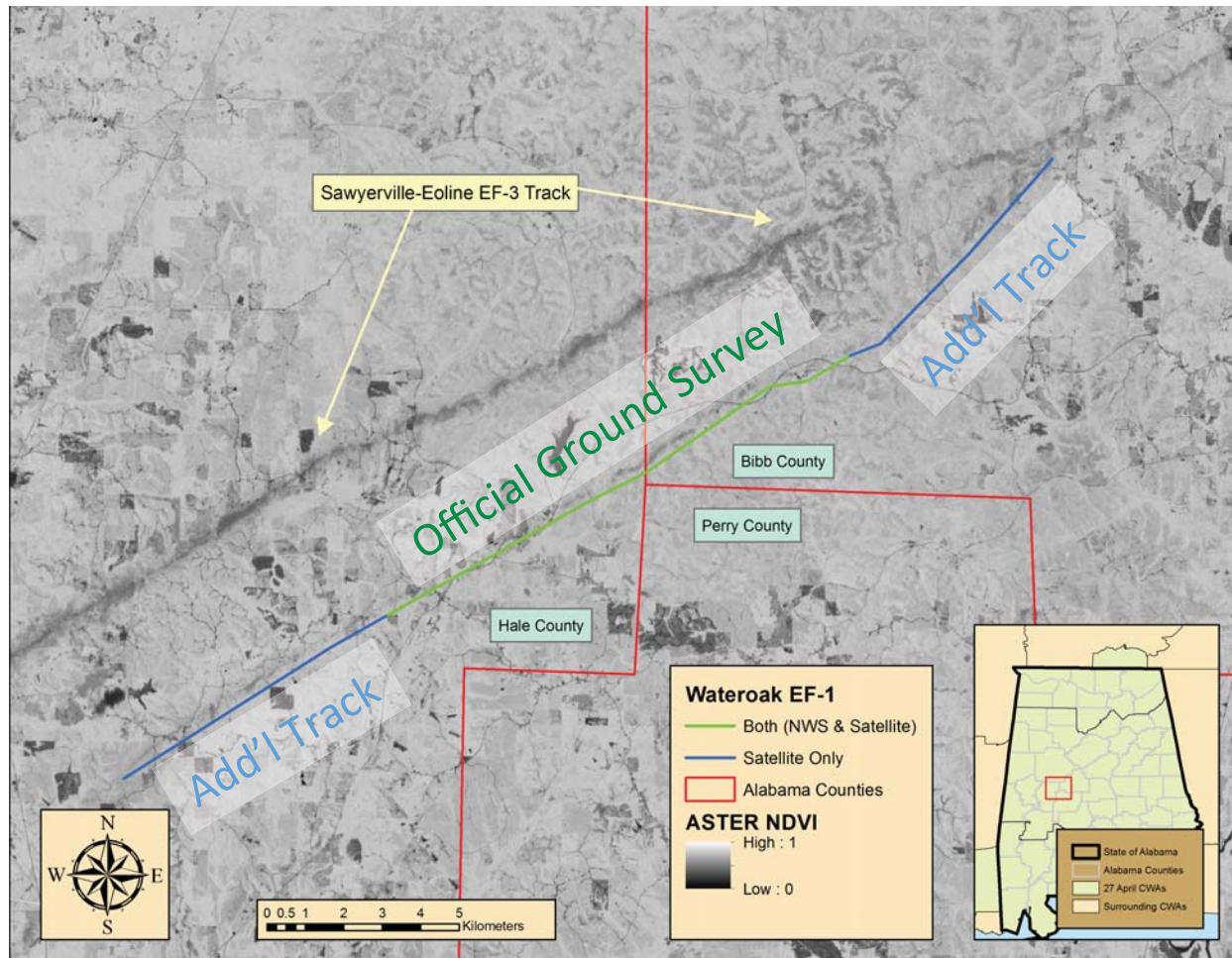
# Case Study: April 27, 2011



- We examined all Alabama tornadoes from April 27, 2011 and track detection from MODIS, Landsat-7, or ASTER.
  - Bell et al. (in review)
- Most tornadoes typically causing disasters (EF-2+) produce tracks visible in NDVI imagery during the primary severe weather season (March-August).



# Case Study: April 27, 2011



In this example, the EF-3 tornado damage track is readily apparent.

An EF-1 track was also surveyed and is apparent from visual inspection, however, the ground survey limited the track extent. It may have been extended if satellite imagery were available.

# Enabling Data Access Integration into the Damage Assessment Toolkit

The screenshot shows a mobile application interface for damage assessment. The top status bar indicates Verizon service, 11:06 AM, and 74% battery. The app header includes 'Back', 'SVR/TOR', 'GPS', and 'Menu' buttons. The main interface is split into a left sidebar and a right map area. The sidebar contains a 'Take Picture' button, input fields for 'Event ID:', 'Storm Date:' (4/27/2011), 'DI:' (Small Barns or Farm Outbuildings (SBO)), 'DoD:' (Threshold of visible damage), a 'Windspeed(mph):' slider set to 62, 'EF Rating:' (EF0), 'Direction:' (N/A), 'Injuries:' (0), 'Deaths:' (0), and a 'Comments:' text area. The map area displays a red 'ASTER False Color Composite' with labels for 'Phil Campbell-Huntsville Track' and 'Haleyville Track'. A vertical scale bar is on the left of the map. On the right, a 'Damage Layers' menu includes 'Basemaps', 'HiRes Imagery', and 'New Survey'. The bottom status bar shows 'Status:Online][TEST]' and 'Cache: (0)'. The 'esri' logo is in the bottom right corner of the map area.



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# Enabling Data Access Integration into the Damage Assessment Toolkit

The screenshot shows a mobile application interface for damage assessment. The top status bar indicates Verizon service, 11:05 AM, and 74% battery. The app has a navigation bar with 'Back', 'SVR/TOR', 'GPS', and 'Menu'. On the left is a form for data entry with fields for Event ID, Storm Date (4/27/2011), DI (Small Barns or Farm Outbuildings (SBO)), DoD (Threshold of visible damage), Windspeed (62 mph), EF Rating (EF0), Direction (N/A), Injuries (0), Deaths (0), and a Comments section. A 'Take Picture' button is at the top of the form. On the right is a map of a red, false-color satellite image (ASTER False Color Composite) showing two tracks: 'Phil Campbell-Huntsville Track' and 'Haleyville Track'. The map includes a scale bar and a 'POWERED BY esri' logo. A 'Damage Layers' menu is on the far right with options for 'Basemaps', 'HiRes Imagery', and 'New Survey'. At the bottom left, a status bar shows 'Status: Online [TEST]' and 'Cache: (0)'.

Back SVR/TOR GPS Menu

Take Picture

Event ID:

Storm Date: 4/27/2011

DI: Small Barns or Farm Outbuildings (SBO)

DoD: Threshold of visible damage ?

Windspeed(mph): 62

EF Rating: EF0

Direction: N/A

Injuries: 0 Deaths: 0

Comments:

Status: Online [TEST] Cache: (0)

Phil Campbell-Huntsville Track

Haleyville Track

ASTER False Color Composite

POWERED BY esri

Damage Layers

Basemaps

HiRes Imagery

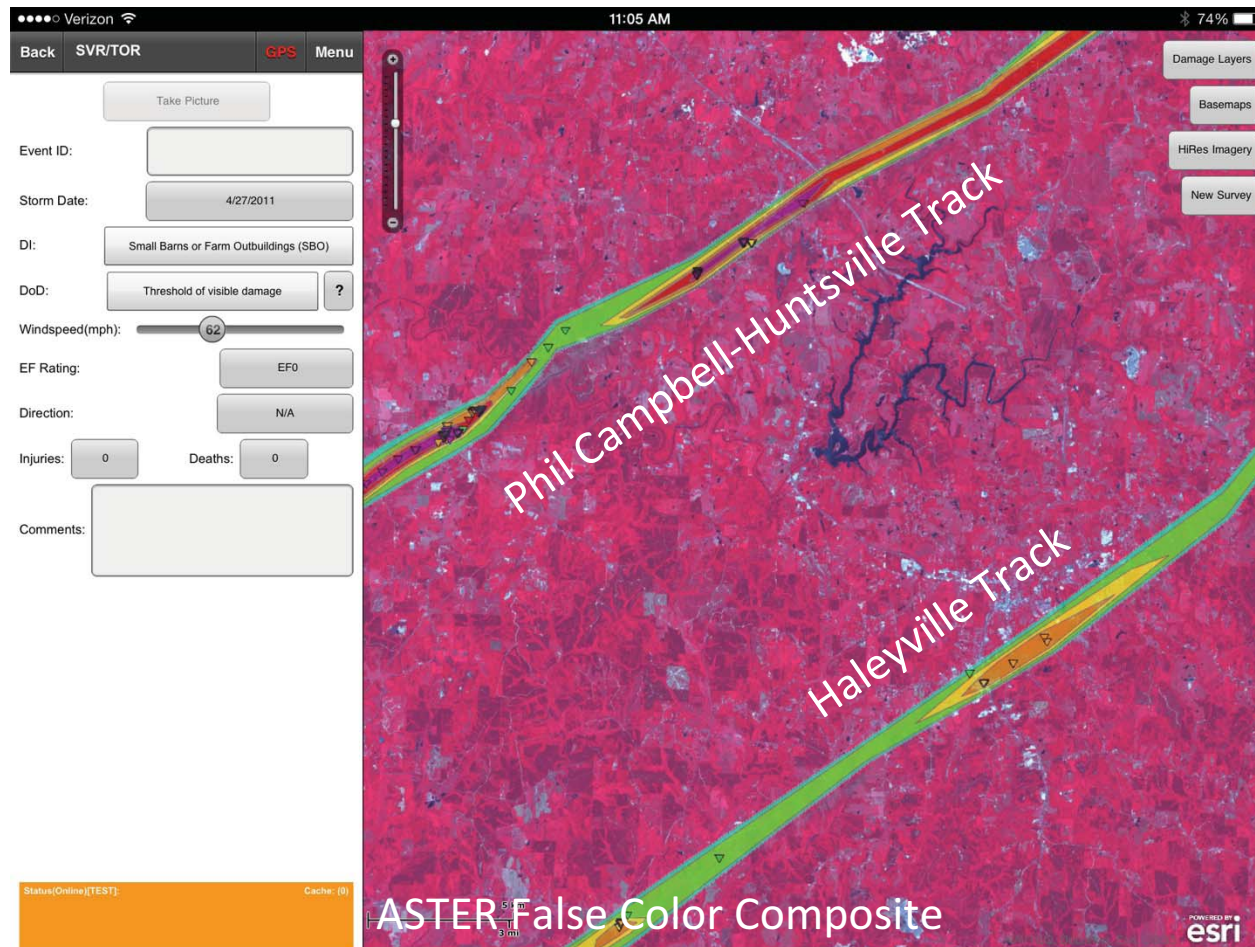
New Survey



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# Enabling Data Access Integration into the Damage Assessment Toolkit



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# Significant Events in 2013

- The feasibility study resulted in an evaluation version of the DAT application, suitable for testing the integration of satellite data sets.
- The SPoRT Disasters Team has examined use of NRT data within the DAT for:
  - The May 20, 2013 EF-5 tornado in Moore, OK
  - The November 17, 2013 EF-4 tornado in Washington, IL

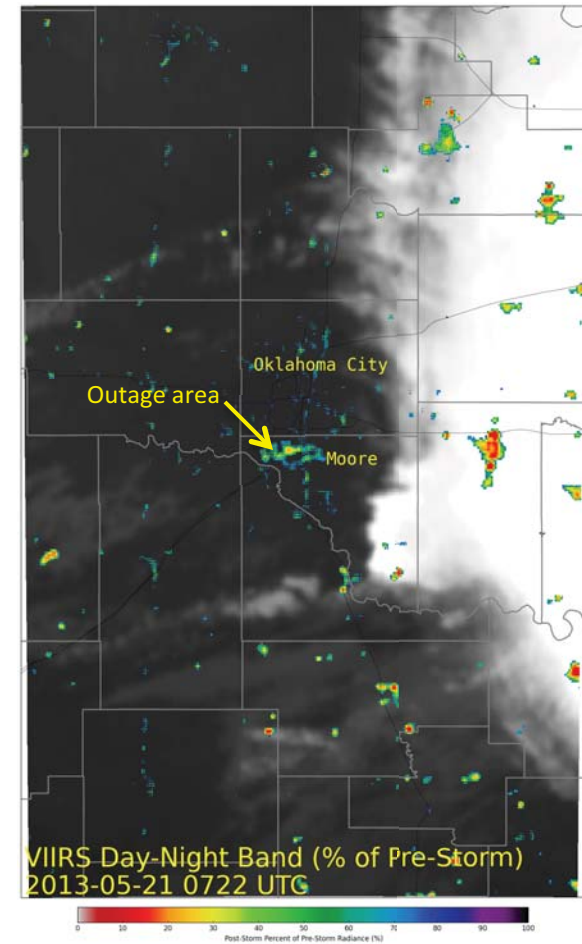
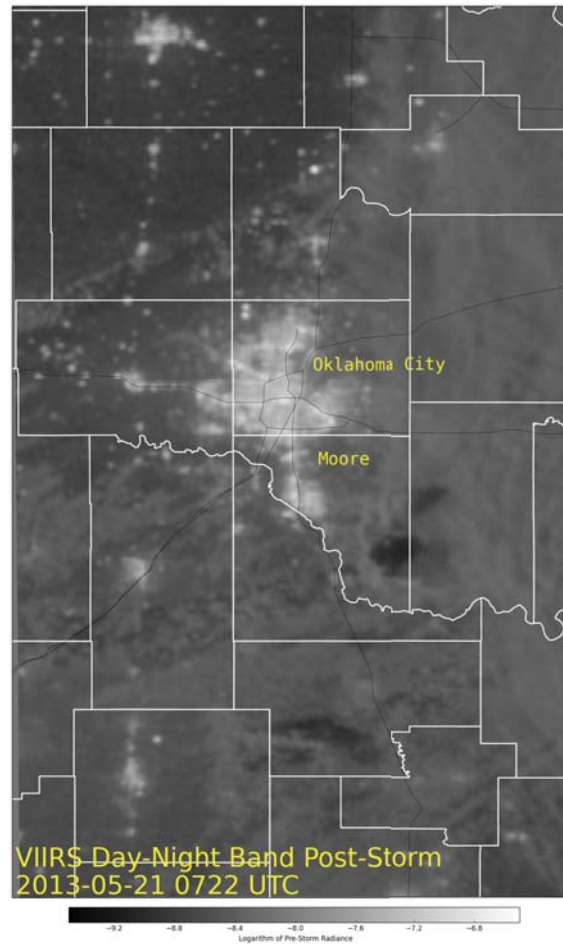
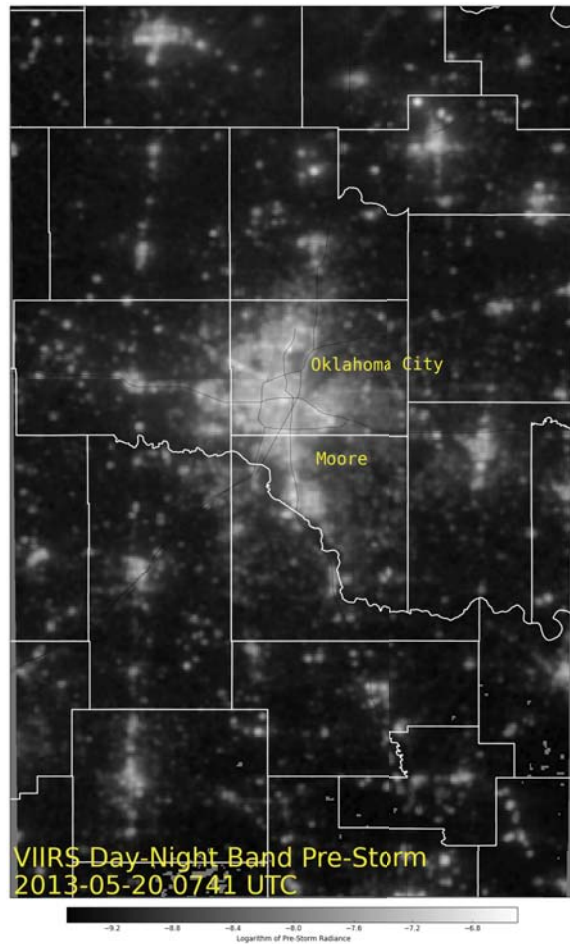


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# Moore, Oklahoma Tornado

May 20, 2013



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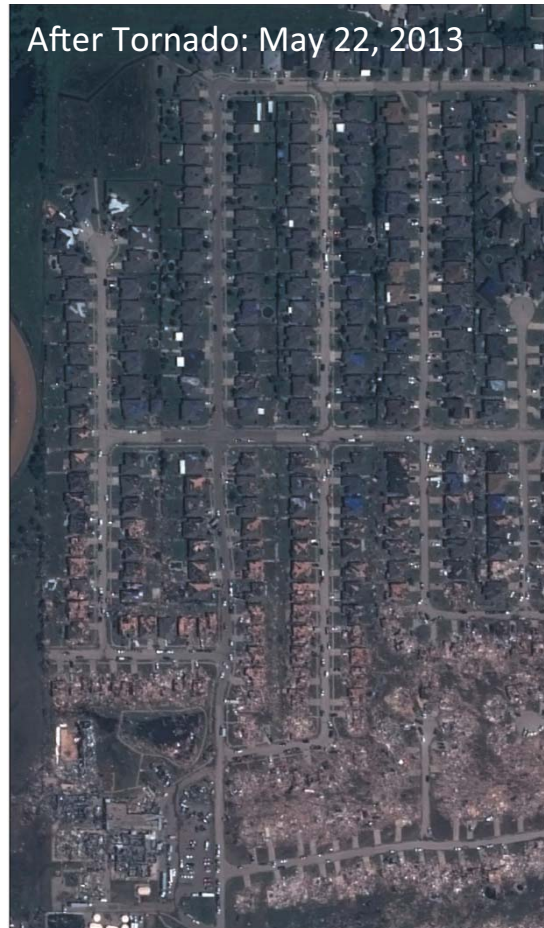
# Moore, Oklahoma Tornado

May 20, 2013

Pre-Event: April 29, 2013



After Tornado: May 22, 2013



Subjective Damage Analysis  
NWS Official Survey

Visible Damage:

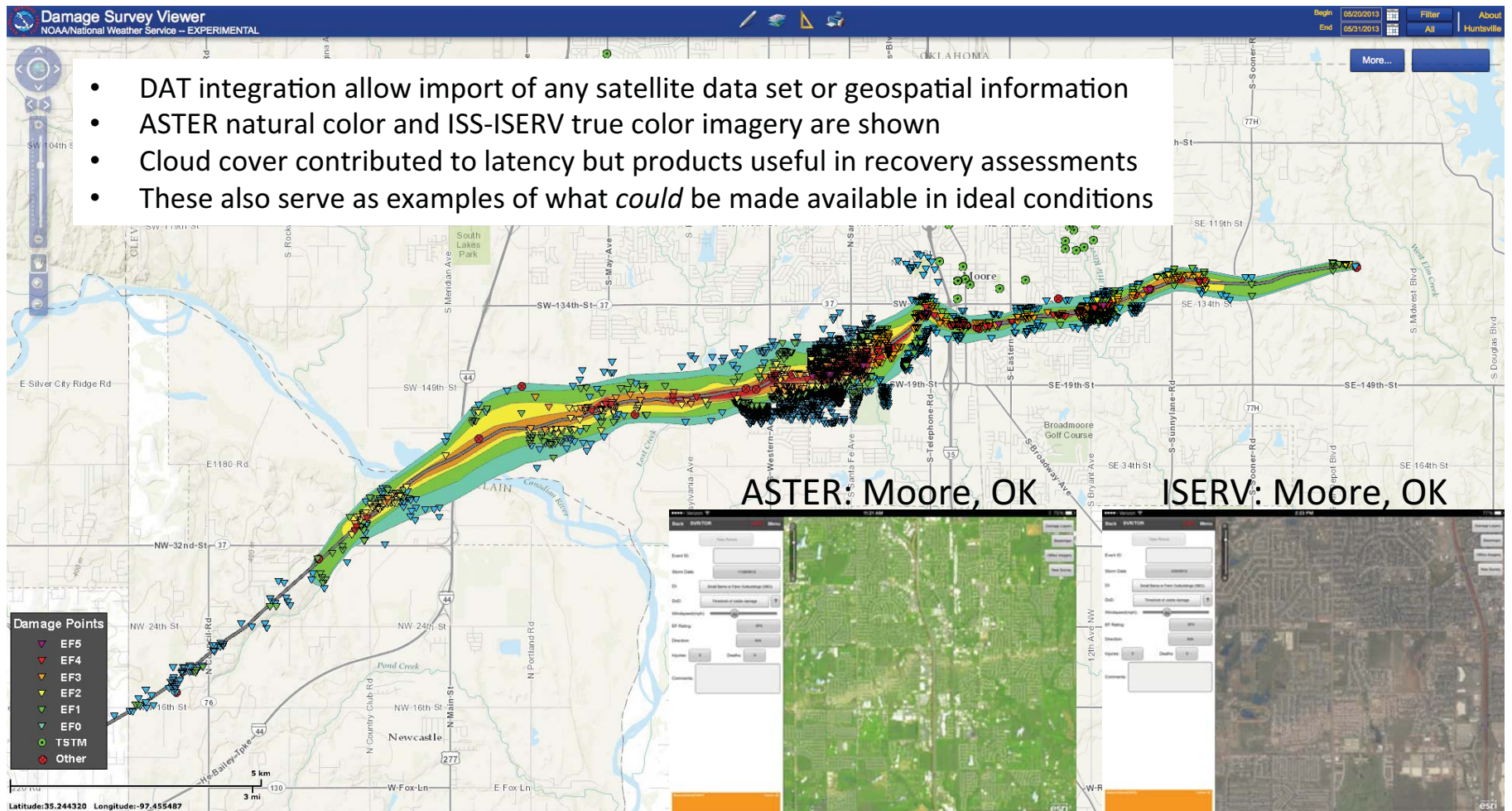
None Light Moderate Heavy





# Moore, Oklahoma Tornado

May 20, 2013

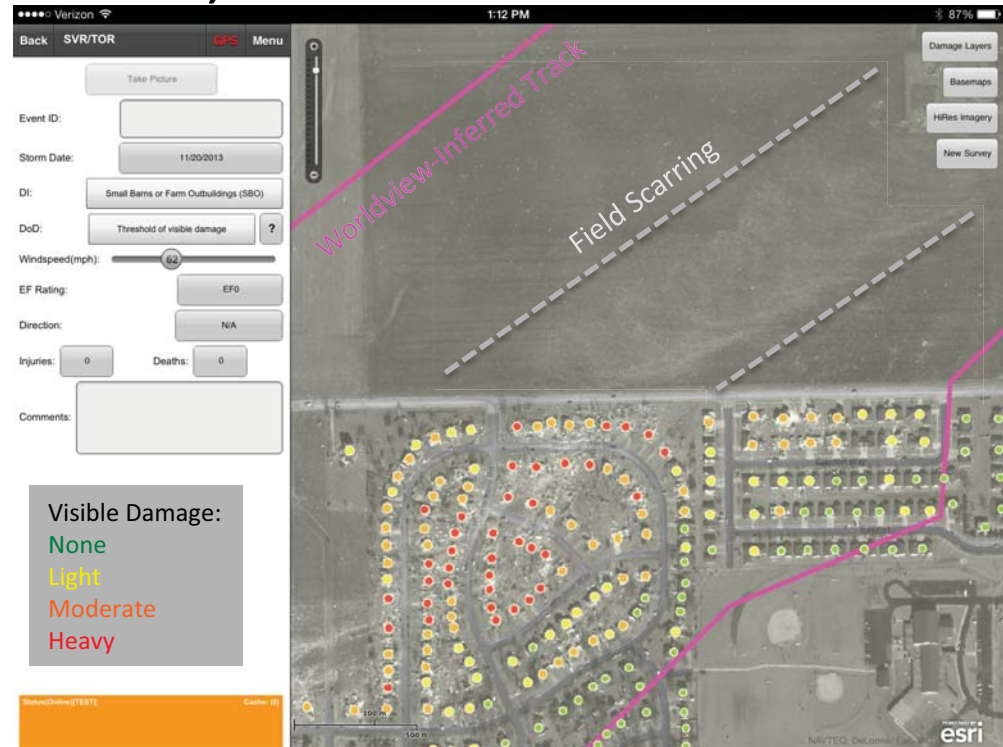
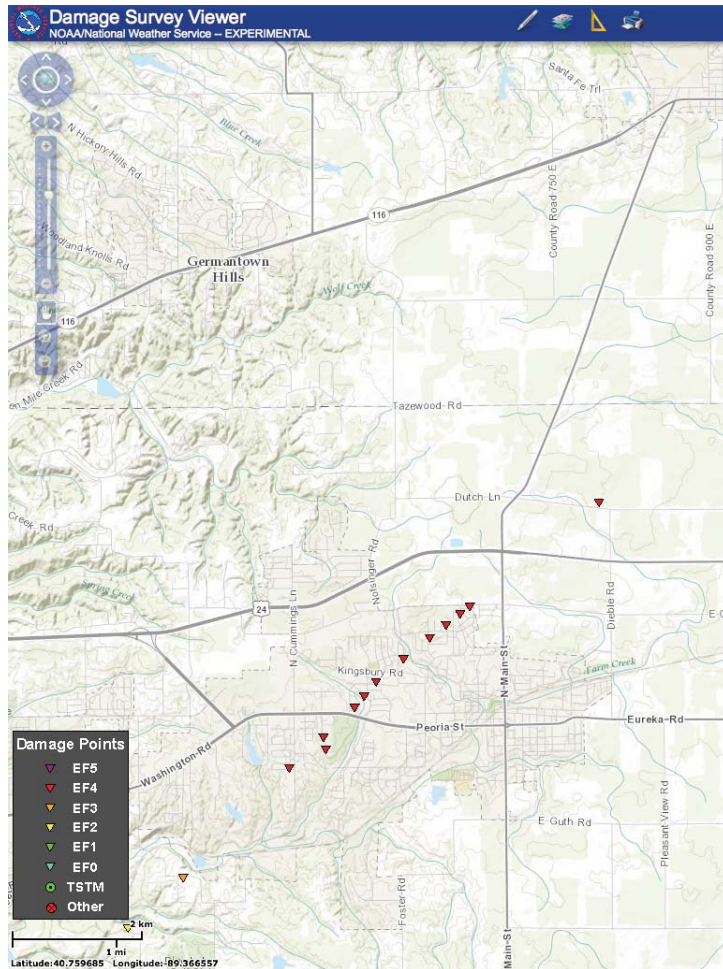


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# Peoria/Washington, Illinois Tornado

November 17, 2013



Worldview image of tornado damage in Washington, IL.  
Damage categories assessed by J. Bell of SPoRT Disasters Team.  
Underlying Worldview panchromatic image (~0.5m) copyright  
DigitalGlobe, provided via USGS for disaster response efforts.



# Early Praise for NASA/NOAA Collaborations

***“Using this (high resolution) imagery, we can revolutionize the way we conduct surveys ... If we had this imagery much sooner (**even within a month**), there's no telling how dead-on we could be with our surveys...and there would be little to no mistaking what actually happened (tornado vs. straight line winds).”***

-- NWS Collaborator, Nashville, TN

“[The proposal team] got us images for the Moore, OK Tornado and the [Norman NWS] ... working with Parks Camp (proposal collaborator, NWS Tallahassee) and NASA ... re-defined the polygon as we were able to make the images available in Damage Assessment Toolkit. The imagery is very useful and has come in very handy for these types of events. Fortunately these also worked for the River Flooding in NWS Central Region's area. ***I think we should support this and the images have already been used in operations.***”

-- NWS Collaborator, NWS Southern Region HQ



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# Summary and Future Work

- The SPoRT Disasters Team has successfully performed a feasibility study demonstrating integration of NRT Earth remote sensing within the NWS Damage Assessment Toolkit
  - Demonstrated benefits from April 27, 2011 case study in addition to high impact events of 2013.
  - Significant, early praise and excitement already received from NOAA/NWS partners.
- The team plans to continue supporting NOAA/NWS partners as part of a three-year Applied Sciences: Decisions award, if received in FY2014.



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# Questions?

- Contact: [andrew.molthan@nasa.gov](mailto:andrew.molthan@nasa.gov)
- Interested in learning more?
  - See our Hyperwall presentation at the NASA Exhibit Booth on Thursday at 10:30 am
  - Several related posters in the poster session
  - Additional information about tornado applications, plus extension to wildfires and tropical cyclones.



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